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APPLICATION FOR UNITED STATES PATENT

Applicant: **Rodger P. Grantham**

Title: **CONTROL OF A/L RATIOS IN VACUUM ASSIST VAPOR RECOVERY DISPENSERS**

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SPECIFICATION

CONTROL OF A/L RATIOS IN VACUUM ASSIST VAPOR RECOVERY DISPENSERS

This claims the benefit of U.S. Provisional Patent Application Serial No. 60/461,725, filed April 10, 2003 and hereby incorporated by reference in its entirety.

Background of the Invention

This invention relates generally to dispensing fuel and, more particularly, to a system and associated method for controlling vapor recovery in vacuum assist vapor recovery dispensers.

In fuel dispensing systems, such as those used for delivering gasoline to the fuel tank of a vehicle, environmental protection laws require that vapors emitted from the tank during the fuel dispensing process be recovered. Fuel is customarily delivered through a nozzle via a fuel hose and vapors are recovered from the nozzle via a vapor hose

that conveys the vapor to the storage tank from whence the fuel came. In what is referred to as a balanced system, the vapors are forced through the vapor hose by the positive pressure created in the vehicle tank as the fuel enters it.

In other systems, referred to as assist-type systems, the vapor is pumped from the vehicle tank and forced into the storage tank by a vapor recovery system connected to the vapor hose. One example of an assist vapor recovery system is described in U.S. Patent No. 6,095,204 issued to Healy and hereby incorporated by reference. Currently, many fuel dispensing pumps at service stations are equipped with vacuum assisted vapor recovery systems that collect fuel vapor vented from the fuel tank filler pipe during the fueling operation and transfer the vapor to the fuel storage tank. Assist type vapor recovery systems use a vapor pump to "assist" in the collection of vapors generated during vehicle fueling.

One criteria of the performance of the fuel dispenser is the ratio of the vapor or air being recovered and returned to the underground storage tank (UST) to the fuel or liquid being pumped from the UST to the vehicle. However, certain variables may affect the valve of the air-to-liquid (A/L) ratio and these variables need to be accounted for to provide a consistent and reliable fueling operation. Typical variables include the pressure drop of the hose and nozzle, the speed of the pump with varying flow rates, meter outputs from grade to grade, pump wear, etc.

Fuel dispensing systems at service stations having vacuum assisted vapor recovery capability which are unable to account for these and other variables waste energy, increase wear and tear, ingest excessive air into the underground storage tank and cause excessive pressure buildup in the piping and UST due to the expanded volume of hydrocarbon saturated air. Such problems could become systematic and present a significant issue that must be addressed.

Summary of the Invention

These and other problems with known fuel dispensing systems and particularly vacuum assist vapor recovery dispensers have been overcome with this invention.

According to one embodiment of this invention, the air-to-liquid (A/L) ratio in vacuum assist vapor recovery dispensers is controlled by utilizing an in-station diagnostics (ISD) system interfaced with the dispenser or a dispenser diagnostics system. Diagnostics systems monitor the performance of the vapor recovery system according to a number of variables. In one embodiment, a diagnostics system is configured to monitor the A/L ratio of each dispensing event using a flow meter placed in the vapor line and a fluid meter placed in the fuel supply line.

A feedback loop from the vapor flow meter to the vapor pump enables a more precise control of the A/L ratio. The actual A/L ratio being measured by the diagnostics system is used to trim the A/L

ratio to the desired setting. This eliminates the impact of the variables mentioned earlier in deteriorating the performance of the vapor recovery system.

Brief Description of the Drawings

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is an exemplary fueling system for a vehicle according to an one embodiment of this invention; and

Figs. 2 and 3 are schematic illustrations of a vacuum assist vapor recovery dispenser interfaced with an in-station diagnostic system according to embodiments of this invention.

Detailed Description of the Invention

Referring to Fig. 1, a vehicle 10 is shown being fueled with a fueling system 12. A nozzle 14 is inserted into a filler pipe 16 of a fuel tank 18 of the vehicle 10 during the fueling operation.

A fuel delivery hose 20 is connected to the nozzle 14 on one end and to a fueling system dispenser 22 on the opposite end. The fueling system 12 includes a vapor recovery system 24. As shown by the cut-away view of the interior of the fuel delivery hose 20, an annular

fuel delivery passageway 26 is formed within the fuel delivery hose 20 for delivering fuel by a pump 28 from an underground storage tank (UST) 30 to the nozzle 14. A central, tubular vapor passage 32 as part of the vapor recovery system 24 is also within the fuel delivery hose 20 for transferring fuel vapors expelled from the vehicle's fuel tank 18 to the UST 30 during the fueling of the vehicle 10. The fuel delivery hose 20 is depicted as having the internal vapor passage 32 with the fuel delivery passage 26 concentrically surrounding it.

As shown in Fig. 1, the UST 30 includes a vent pipe 34 and a pressure vent valve 36 for venting the UST 30 to the atmosphere. The valve 36 vents the tank 30 to air at about 3.0 inches H_2O or -8.0 H_2O.

A vapor recovery pump 38 provides a vacuum in the vapor passage 32 for removing fuel vapor during a refueling operation. The vapor recovery pump 38 may be placed anywhere along the vapor recovery system 24 at or between the nozzle 14 and the UST 30. Vapor recovery systems 24 utilizing the vapor recovery pump 38 of the type shown and described herein are well known in the industry and are commonly utilized for recovering vapor during refueling of conventional vehicles which are not equipped with on-board vapor recovery systems (ORVR). The vehicle 10 as shown in Fig. 1 being fueled may include an ORVR system 40.

The vehicle fuel tank 18 of an ORVR vehicle 10 typically has an associated on-board vapor recovery system 40. These ORVR systems 40 typically have a vapor recovery inlet 42 extending into the

fuel tank 18. As the fuel tank 18 fills, pressure within the tank 18 increases and forces vapors into the ORVR system 40 through the vapor recovery inlet 42. Alternatively, the ORVR system 40 may use a check valve (not shown) along the filler pipe 16 to prevent further loss of vapors. One mechanism that may be included in the fuel dispenser 22 of this invention to make the ORVR system 40 more compatible with the vapor recovery system 24 is disclosed in U.S. Patent Application Serial No. 10/684, 051, filed October 10, 2003 and hereby incorporated by reference in its entirety.

As liquid fuel rushes into the fuel tank 18 during the fueling operation, fuel vapors are forced out of the fuel tank 18 through a spout 44 of the nozzle 14. The vapor recovery system 24 pulls the fuel vapors through the hose 20 along the vapor passage 32 and ultimately into the UST 30. This is the standard operation when fueling vehicles not equipped with ORVR systems.

According to this invention and as shown in Figs. 2 and 3, assist type vapor recovery systems 24 use the vapor pump 38 to "assist" in the collection of vapors generated during vehicle fueling. The speed of the vapor pump 38 or rate at which the vapors/air are pulled from the fuel tank 18 may be correlated to an output of a liquid meter 46 measuring the rate of fuel being pumped by the dispenser 22 to the fuel tank 18. An electronic control interface 48 between the meter output 46 and the speed control of the vapor pump 38 allows the ratio of vapor/air flow to fuel/liquid flow (A/L ratio) to be adjusted to the desired level.

Once this setting is adjusted, it may be established as a fixed value, which in one embodiment is preferably about 1.0 (i.e., A/L=1.0). In many cases, an A/L ratio in the range of 0.95/1.0 to 1.05/1.0 is targeted because precision is often difficult to achieve, especially as the components of the system wear.

Certain variables may affect the value of the air-to-liquid (A/L) ratio and these variables need to be accounted for. Typical variables include the pressure drop of the hose 20 and nozzle 14, the speed and/or efficiency of the pump 38 with varying flow rates, meter outputs from grade to grade, pump wear, etc.

According to this invention, a diagnostics agent 50 is introduced for controlling the A/L ratio in vacuum assist vapor recovery dispensers 22 by utilizing an in-station diagnostics (ISD) system remote from the dispenser 22 but interfaced with the dispenser 22 (Fig. 2) or a dispenser diagnostics system located with the dispenser 22 (Fig. 3). Diagnostics agent 50 monitors the performance of the vapor recovery system 24 according to a number of variables. For example, the diagnostics agent 50 may be configured to monitor the A/L ratio of each dispensing event using a flow meter 52 placed in the vapor line 32 and a flow meter 46 placed in the fuel supply line 26.

A control interface 48 in communication with the diagnostics agent 50 enables more precise control of the A/L ratio. Specifically, in one embodiment, the diagnostics agent 50 is in communication with the vapor flow meter 52 via loop 54 and in

communication with the fuel flow meter 46 via loop 56. A feedback loop 58 from the diagnostics agent 50 through the control interface 48 is provided via feedback loop 60 to the vapor pump 38 and via feedback loop 62 to the fuel pump 28. The feedback loops to one or both of the pumps 28, 38 based on the respective flow rates measured by the flow meters 46, 52 enables a more precise control of the A/L ratio.

Preferably, one or both of the flow rates are adjusted to achieve an A/L ratio of about 1.0. The actual A/L ratio being measured by the diagnostics agent 50 would be used to trim the A/L ratio to the desired setting. This would eliminate the impact of the variables mentioned earlier in deteriorating the performance of the vapor recovery system 24.

The retrofit of an existing fuel system 12 to accomplish such an improvement is a simple matter of hanging a new nozzle assemble in the fuel system. It should be appreciated by those of ordinary skill in the art that the retrofit of existing fuel systems is easily accomplished with the implementation and installation of an assembly as described herein. Additionally, the installation of new fuel systems preferably includes an assembly according to this invention.

From the above disclosure of the general principles of the present invention and the preceding detailed description of at least one preferred embodiment, those skilled in the art will readily comprehend the various modifications to which this invention is susceptible.

Therefore, I desire to be limited only by the scope of the following claims and equivalents thereof.

I claim: